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The effect of a 4 week plyometric training period on lower body muscle EMG changes in futsal players

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Abstract

This study focused on the effect of a 4-week, plyometric training period on lower body muscle electromyography(EMG) changes in university futsal players. Thus, 14 players of a varsity futsal team with an average age of 19.1-22.6, height of 159.4-182.5 centimeters, and weight of 58.9-76.9 kilograms were chosen. The subjects participated in four weekly 45-60 minute training sessions in a 4 week period. Before and after the 4 week period, the EMG for the biceps femoris and gracilis were checked. A paired t-test with α=0.05 was used. The results revealed that 4 weeks of plyometric training had a significant effect ($p<0.05$) on the EMG of the biceps femoris while performing the Squat Movement(absolute strength) but the EMG for the biceps femoris was insignificant ($p>0.05$) for the vertical jump(explosive power).

Keywords: EMG, Plyometric, futsal, athlete

1. Introduction

In sports competitions, athletes usually break previous records and set new ones. Better results is usually because o a rise in the athletes physical, mental and technical readiness. Higher readiness is due to a better understanding of the exercises and their results by trainers and athletes. Resistance and plyometric training are very important in training programs (Bompa. T.O, 1994).

Performing these tasks in a 3-6 month period can lead to a 20-100 percent improvement in muscle power. Plyometric training improves the athlete's explosive power and speed. Plyometric exercises consist of eccentric contractions directly followed by concentric contractions. Strength can be noted as an athlete's most important physical attribute and plays an important role in almost every sport. Plyometric or jumping exercises are relatively new in resistance training, getting much attention in the late 80's to enhance the jumping abilities of athletes, they are used to bridge the gap between speed and strength exercises to ease the accessing of motor units(Wilmer & Castel, 1994).

Because of the importance of strength, trainers and athletes must be familiar with exercises that lead to an increase in strength. These exercises can be done with minimal facilities and even without equipment. Using

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plyometric exercises in sports needing a lot of strength is of greater importance. The most important feature of these types of exercises is the simultaneous improvement of the athlete's skill patterns.

Through creating changes in the muscle's nervous system, plyometric training increases the ability of muscle groups in responding faster and stronger to muscle changes. One of the major problems in plyometric training is following safety precautions to prevent injury in athletes of different ages, especially adolescents. Therefore, this type of training requires precise control over the intensity and volume of exercise for all age groups(Bompa. T.O, 1994).

If safety precautions are not followed while plyometric training, the knee, shin, ankle and back can be subject to injury. Too many training sessions, too many jumps in each stage, faulty jumps and jumping on hard surfaces are the causes of such injuries. This type of exercise can lead to injury at very young ages, before general strength is acquired. The belief that plyometric training is only useful for increasing explosive power and that it has little effect on the athletes' maximal strength has led most trainers to discard this training method from their training programs. But is this belief true? Can the athletes' maximum strength be obtained through plyometric training?

Research has shown plyometric training an effective method in increasing strength. In a study by Chimera (2004), the effect of plyometric training on muscle activity and performance strategies of female athletes was researched. 20 female student athletes participated in this study. The subjects were pre- and post-tested. The participants had 2 weekly plyometric training sessions for a period of 6 weeks. In this study, a surface EMG was used to calculate the primary and secondary electric activities of the vastus medialus, vastus lateralis, inner and outer hamstrings, and thigh adductor and abductors. Results showed that adductor electric activities increased after plyometric exercise and that the effect of plyometric training on female muscle activities and performance was significant.

In another study, done in Virginia, Silicox (2004) investigated if there was a difference between the electric activity of the inner- and outer-hamstring of males and females when landing after 2 weeks of plyometric training. 17 Virginia female and male soccer players were studied. No significant differences were noticed between the two genders when landing, but outer-hamstring electric EMG activity increased after the plyometric training program.

Muscle power depends on the amount of nerve stimulation and the number of active motor units. To evaluate the power production mechanism, muscle activities will be studied and compared through direct measurement techniques. Inner-muscular neural adaptations consist of using motor units, the amount of stimulation and inter-muscular harmony. A qualitative procedure that can be used with the existing methods and can make needed quantitative measurements is the EMG.

This harmless procedure can calculate the amount of current and organized activities of some lower body muscles that engage in different movements. Muscle movements start with electric activities and the recording of these signals is known as the EMG method. The size of the muscle's recorded electric signal depends on different factors. The type and size of the electrode, the amount of change in the length of muscle fiber and the type of muscle are among the signal changing factors.

The EMG signal is the algebraic sum of the motor units' potential activity where the electrode is placed. These motor units are usually not active simultaneously and are function at different times. Motor units are controlled by a group of neurons. These neurons can transmit either excitatory or inhibitory impulses. The contraction or expansion of muscle cords depends on the signals that reach a motor unit at that time. A motor unit will become active and its muscles will contract only when the amount of excitatory impulses are more than inhibitory impulses and higher than the level of threshold (Wilmer & Castle, 2008).

EMG can calculate recurrent pressures to movement systems and haemostatic activities that occur while doing sports. Thus, through EMG results, better training methods and facilities can be considered for athletes. Reviewing different studies, it seems that physiological activities that are influential to neuromuscular adaptations in power training and that lead to an increase in the power the organ creates are unknown. In previous studies, simple methods for considering and comparing different training methods have been used, but this study applies advanced technology and is performed scientifically. Therefore, this study plans to inspect 4 weeks of plyometric training on lower body muscle EMG changes and the response of the trained organ to power training.

2. Methodology

2.1. Participants

This study is of applied nature and is semi-experimental. The participants were varsity futsal players (N=52). For this study 14 of the players were chosen randomly, after which they signed consent forms. Using a questionnaire, the subjects made clear that they had no records of pain or surgery and that they were completely healthy. Their age ranged from 19.1-22.6 years, their height from 159.4-182.5 centimeters, and their weight from 5.9-76.9 kilograms.

2.1.1. Measurement

The effect of plyometric training on the EMG of the biceps femoris and gracilis was measured when performing the pre-test and, after 4 weeks of training, during the post-test. For better results, EMG changes for each muscle were performed in the 2 virtual forms of absolute strength (Squat movement) and explosive power (vertical jump). To prevent the negative effect of pressure resulting from the squat movement on the vertical jump, the latter was performed first. To record the information, an MT machine was used, and MYO-Dat5 was used to analyze the data. To perform the pre- and post-tests a multi-press rack, a wall-mounted sergeant jump scale, Megawin Ver.2, and an MIE electro-goniometer was used.

2.1.1.1. Procedure

The training program consisted of a 4-session, weekly training program in a 4 week period. To enhance the participants' physical abilities and preparation, light training activities were performed in the first week and activities such as Hurdle jump and depth jumping were not performed. The amount of training pressure was gradually increased from the second week onward. The number of repeats depended on the pressure of the activities during the training program. An important factor that was considered during the training period was the performance of the plyometric movements on a suitable surface to prevent possible injuries.

2.1.1.1.1. Statistical Analysis

To examine the hypotheses, a paired t-test with $\alpha=0.05$ was used. Statistics were analyzed using SPSS ver.16.

3. Results

This study showed that 4 weeks of plyometric training had a significant effect (P=0.019) on EMG of the biceps femoris when performing the squat movement (absolute strength), whereas the effect on EMG when performing the vertical jump (explosive power) was in significant (P=0.052)

Table 1. Paired T-test for the pre- and post-test of the biceps femoris

varibles	***Per-test***	***Pos-test***	***significance****
Squat Movement	1.782± 0.545	2.064± 0.692	0.019*
Vertical jump	1.805±0.697	2.042±0.568	0.052

This study also showed that 4 weeks of plyometric training significantly effected the EMG of the gracilis (P=0.002) while performing the squat movement (absolute strength), effecting the EMG of the gracilis (P=0.000) in the vertical jump (explosive power) as well.

Table 2. Paired T-test for the pre- and post-test of the gracilis

varibles	***Per-test***	***Pos-test***	***significance****
Squat Movement	1.782± 0.545	2.064± 0.692	0.019*
Vertical jump	1.805±0.697	2.042±0.568	0.052

4. Discussion and conclusion

The findings of this study showed that 4 weeks of 4-session per week plyometric training caused an increase in EMG changes in the biceps femoris for the squat movement (absolute strength). The nature and type of plyometric exercises add much force and tension to muscle cords. Performing such activities or tolerating extreme force and tension may lead to needed physiological or biological changes in muscle cords and other parts of the contraction system and can also cause muscle EMG changes to rise. Hence, at higher levels, when an athlete is trying to reach maximum strength, it is probable that plyometric training will not be as influential as weight training. The findings of Olson (2010) and Chimera (2004) verify these results, whereas those of Herrero (2006) and Arabatzi at al. (2010) state otherwise.

Statistical analysis of the findings of this study showed that 4 weeks of plyometric training in 4 weekly sessions caused no significant increase in the muscle EMG of the biceps femoris when performing the vertical jump (explosive power). The cause can be noted as insufficient training specific to the muscle or the insufficiency in the severity of training. These findings are similar to those of Herrero (2006), opposing Potach et al. (2007).

This study emphasized that 4 weekly plyometric training sessions in a 4 week period had a significant effect on the EMG changes of the gracilis when the subjects performed the squat movement (absolute strength). Myer et al. (2006), Pollock (2010), Kato (2010) and Kubo (2007) also found changes in EMG and the strength of other muscles. Henry et al. (2010) and Herrero (2006) reached other conclusions. Some of the reasons for such a variety of results may be noted as the difference in participants, type of exercises applied, the time of training and the difference in the muscles studied. This study also emphasized that 4 weeks of plyometric training effected gracilis EMG while performing the vertical jump (explosive power). The reasons for such an effect can be stated as the severity of plyometric training and its effect on the muscles contraction elements and the muscles physiological changes. Ball and Scurr (2009) and Potach (2007), too, found the vertical jump influential.

This study shows that a 4-week plyometric training period can create improvement in muscle strength in some lower-body muscles of futsal players. These types of exercises can be used for preparation seasons, as well as competition seasons to increase lower-body muscle strength in futsal players.

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